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COMMUNITIES FOR A BETTER ENVIRONMENT

23 February 2016

Ryan Hostetter, Project Manager
San Luis Obispo County Department
of Planning and Building
County Government Center
San Luis Obispo, CA 93408

Re: **Expert Report of Greg Karras, Communities for a Better Environment (CBE), regarding the Phillips 66 Company Rail Spur Extension and Crude Unloading Project, Final Environmental Impact Report (FEIR), and Staff Report released 25 January 2016, SCH #2013071028, San Luis Obispo County File #DRC2012–00095**

Dear Ms. Hostetter,

CBE respectfully transmits the above-cited report providing additional evidence that:

- The County correctly finds that project delivery of crude oil imports by rail could cause significant pollution and catastrophic hazard impacts. The FEIR may understate these impacts, however, and the potential for catastrophic and irreversible impacts should not be understated.
- The FEIR overestimates impacts from not proceeding with the project. Its "No Project" Alternative analysis erroneously includes new actions to import oil via a train-to-truck scheme that is not reasonably likely to proceed given safer and less costly options.
- Processing the new and different imported crude slate enabled by the project would be likely to result in significant refinery emission and catastrophic hazard impacts that the FEIR does not identify or address. Oil feed properties that affect processing and would change with the new "tar sands dilbit" crude slate would increase refinery emissions and hazards. For example, feedstock-driven increases in refinery emissions could be many times greater than the total county- or state-wide increments the FEIR estimates for SO_2 and CO_2. The FEIR does not report these crude slate changes or address these impacts, and its reliance on surrogate measurements that are known to be unrepresentative of the impacts from dilbit crude slates at individual plants obscures these crude slate impacts.

This evidence further supports the Staff Report recommendation <u>not</u> to approve the project.

Greg Karras
Senior Scientist

Enclosure: Expert report cited above

Expert Report of Greg Karras
Communities for a Better Environment (CBE)
23 February 2016

Regarding the

Phillips 66 Company Rail Spur Extension and Crude Unloading Project
Final Environmental Impact Report (FEIR) dated December 2015
and **Staff Report** released 25 January 2016
County of San Luis Obispo, California
State Clearinghouse #2013071028
County File #DRC2012–00095

Contents

I, Greg Karras, declare and say:

1. I reside in unincorporated Marin County and am employed as a Senior Scientist for Communities for a Better Environment (CBE). My duties for CBE include technical research, analysis, and review of information regarding industrial health and safety investigation, pollution prevention engineering, pollutant releases into the environment, and potential effects of environmental pollutant accumulation and exposure.

Qualifications

2. My qualifications for this opinion include extensive experience, knowledge, and expertise gained from more than 30 years of industrial and environmental health and safety investigation in the energy manufacturing sector, including petroleum refining, and in particular, refineries in the San Francisco Bay Area. I have discussed my qualifications, experience, knowledge and expertise in a previous report in this matter and have provided my curriculum vitae and list of publications with that previous report. Please see the Expert Report of Greg Karras, Communities for a Better Environment (CBE) that is dated 24 November 2014, and my curriculum vitae and publications list attached thereto, for this information.

Scope of Review

3. In my role at CBE I have reviewed the proposed project called the Phillips 66 Company Rail Spur Extension and Crude Unloading Project (project), the Revised Draft Environmental Impact Report (RDEIR) dated October 2014, the Final Environmental Impact Report (FEIR) dated December 2015, and the Staff Report on the project released by San Luis Obispo County on 25 January 2016. The Staff Report recommends denial of the project. My previous comments on the project and RDEIR were focused on the primary energy source and scope of the project as those relate to its potential environmental impacts. I reassert my previous comments as they have not been addressed adequately in the FEIR and remain relevant, to the extent that the FEIR may be considered for certification. Following the release of the FEIR and Staff Report for public comment, I have been asked for my opinion on three questions:

- Would the project be likely to result in the significant pollution and catastrophic hazard impacts associated with crude oil delivery identified in the Staff Report?
- Does the future truck delivery assumption in the FEIR <u>overestimate</u> impacts of the No Project Alternative by overestimating its effect on oil truck traffic?
- Would the project be likely to result in significant air emission and catastrophic hazard impacts associated with oil processing that are <u>not</u> identified in the FEIR or the Staff Report, or are <u>underestimated</u> in the FEIR and the Staff Report?

My review of the project, Staff Report, and FEIR reported herein is focused on these three questions. My opinions on these matters and the basis for these opinions are stated in this report.

Significant Oil Delivery Impacts of the Project: The project would be likely to result in the significant pollution and catastrophic hazard impacts associated with crude oil delivery that are identified in the Staff Report.

4. The Santa Maria Facility (SMF) and San Francisco Refinery (SFR) of which the SMF is an integral part currently lack any capacity to receive crude oil delivered by rail.

5. New and modified equipment that the project would install at the SMF would enable unloading crude oil delivered by "unit" trains up to 5,190 feet long, each carrying up to ≈52,000 barrels of ≈21.5 ºAPI crude oil, according to the FEIR. (§ 2.0.) Tar sands bitumen extracted in Canada and mixed with lighter diluent oils ("dilbit") would likely dominate the crude oils delivered. (<u>Id</u>.) The project would deliver crude via oil trains that travel through California and other western states, and through San Luis Obispo

County from the Bay Area to the north, the Los Angeles Area to the south, or both alternatively, to the SMF. (Id.) Up to 250 trains per year could deliver an average of ≈ 37,142 barrels per day (b/d) of crude, according to the FEIR (Id.), however, the project would create the physical capacity to offload at least 330 trains per year (48,950 b/d), and the FEIR relies on a proposed project limit of 250 trains/year[1] in its analysis.

6. Increased use of oil trains is generally known to increase air pollutant emissions from locomotive fuel combustion and "fugitive" leaks during crude oil transport and loading operations, and to increase rail incident hazards from oil train derailments, oil spills, fires, and explosions. Across North America during the first five months of 2015, for example, no less than five catastrophic oil train derailment incidents were reported.[2]

7. The Staff Report finds[3] that increases in criteria and toxic air pollutant emissions and in oil spill, fire, and explosion hazards from project oil transport and unloading at the SMF would result in significant impacts on air quality, environmental health, and public safety, rendering the project inconsistent with County plans and policies.

8. Detailed analysis of oil train emissions and hazards in the FEIR supports the Staff Report findings. Quantitative emission and air exposure hazard assessments in the FEIR indicate that project operations would result in significant impacts on air quality and environmental health near the SMF and along the rail routes in many California counties including San Luis Obispo County (SLOC). (§ 4.3: *see* also appendices B.1 and B.2.) These impacts would be caused by increased toxic air contaminant, reactive organic gas (ROG), particulate matter (PM), and nitrogen oxide (NOx) emissions from oil delivery and unloading. (Id.) With respect to catastrophic hazard, a quantitative risk assessment in the FEIR indicates that project operation would result in significant impacts on public health, public safety and the environment by increasing oil train derailment, spill, fire, and explosion hazards along rail routes in SLOC and many other California counties. (*See* §§ 4.2, 4.3, 4.4, 4.5, 4.7, 4.11 and 4.13; *see* esp. § 4.7 and appendices H.1–H.4.)

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[1] My November 2014 Expert Report (hereinafter "Karras Report–1") showed that at its stated capacity to unload a train in ≈ 11.5 hours, the project would be limited to the SMF throughput limit of 48,950 b/d, or ≈ 344 trains/yr (Karras Report–1 at 3.) The FEIR responds that a newly-proposed unloading limit would hold the project to 250 trains/yr. But that proposed limit could later be relaxed—the 48,950 b/d SMF limit itself was relaxed from 44,500 b/d. (FEIR at 2-36.)

[2] *See* "Crude Injustice on the Rails" (Attachment K2-2); background section at page 21.

[3] *See* Exhibit A at C 1–2, D 1–4, D 6 and E 1–2; Exhibit B at A 1–3, B 1–4 and C 1–8; and Exhibit C at paragraphs 7, 9, 10, 12–26, 28–30, 32, and 33.

9. Emissions and hazard from oil train transit and unloading could be greater than those estimated by the FEIR because the project could deliver more oil than it assumes. The physical capacity of the project to unload a train in ≈ 11.5 hours (§ 2.0), combined with the existing SMF capacity to process that oil based on its throughput limit, could enable up to 48,950 b/d to be unloaded from ≈ 330 trains/year, instead of the ≈ 37,142 b/d from 250 trains/year assumed by the FEIR. (*See* ¶ 5 and footnote 1.) This larger capacity of post-project infrastructure represents the project potential. The FEIR assumes a proposed 250 trains/year limit will be adopted and retained throughout the life of the project,[4] but the recent raising of the SMF throughput limit from 44,500–48,950 b/d (FEIR at 2-36) shows that proposed infrastructure capacity can eventually be utilized. Further increased oil train frequency and unloading volume can be expected to further increase impacts, and the FEIR's emission (§ 4.3; appendices B.1, B.2) and hazard (§ 4.7; App. H.1 at H.1-20) analyses clearly show its impact results are sensitive to this factor. Should the proposed project limit be rejected, or later raised to be consistent with the Air District SMF limit—as the County's SMF limit was recently (FEIR at 2-36)—the project could unload up to 330 trains/year, a 32 % greater throughput than the 250 trains/year analyzed in the FEIR. This conservatively assumes SMF limits will not further increase.

10. A World Health Organization (WHO) report on its guidelines for the protection of public health from certain air pollutants is appended hereto as Attachment K2-1. The WHO 24-hour exposure guideline for fine particulate matter ($PM_{2.5}$) is 25 ug/m^3 in the ambient air. (Att. K2-1.) The WHO criterion is more protective of air quality and health than the U.S. National Ambient Air Quality Standard criterion for $PM_{2.5}$ that the FEIR relies upon in its analysis of 24-hour exposures (35 ug/m^3). This evidence suggests that reliance on under protective significance criteria may further understate the severity and geographic extent of the significant impacts estimated in the FEIR.

11. Cancer risk from exposure to toxic air contaminants emitted by the project is judged significant in the FEIR if it exceeds ten per million people exposed (10/MM). (*See* p. 4.3-52.) This 10/MM threshold is within the 1/MM–100/MM range of those typically applied in policy decisions within the U.S. and California, but would still classify a number of expected cancers from the project as "less than significant," and thereby reveals another example of potentially under protective significance criteria.

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[4] *See* FEIR Responses to Comments (RTC); response to CBE Comment #73 ("CBE-73").

12. Other evidence further suggests some toxicity criteria may understate impacts. Recently, the California Office of Environmental Health Hazard Assessment (OEHHA) found that its cancer risk guidelines for multiple toxic air pollutants were substantially under protective of children, and corrected the errors. (*See* FEIR at 4.3-22.) The FEIR uses the corrected guidelines in its analysis. (Id.) However, project EIRs and approvals throughout the state still relied until last year on the incorrect, underprotective guidance, and despite the discrepancy between US and WHO $PM_{2.5}$ criteria shown in paragraph 10, OEHHA has not yet established a toxicity factor for undifferentiated $PM_{2.5}$.

13. The Staff Report includes specific findings that the project is not consistent with SLOC plans and policies to ensure equity in the protection of vulnerable populations and persons from oil train hazards including oil spills, fires, explosions and emission hazards. (*See* esp. Exhibit A at D 4; Exhibit B at C 6, and Exhibit C at ¶¶ 25, 29, and 32.)

14. A report I co-authored that was published by CBE and ForestEthics after my previous comments in this matter is appended hereto as Attachment K2-2. This report documents disparities in oil train-related hazards within the so called blast zone, the one-mile swath along oil train routes within which the U.S. Department of Transportation (USDOT) recommends evacuation in a multi-car oil train derailment and fire. Among other things, the report shows that communities of color are disparately exposed to catastrophic hazards and emissions associated with oil trains—both statewide, and in at least seven major industrial cities that project oil trains could further affect, including: Los Angeles, San Jose, Oakland, Richmond, Fremont, San Bernardino, and Stockton.

15. Comments on the RDEIR by the Santa Barbara County Planning Director that are dated 19 November 2014, along with the FEIR responses to them, are appended hereto for the reader's convenience as Attachment K2-3. Among other things, the Planning Director commented on the catastrophic, potentially irreversible hazard posed by the project and on the importance of fully analyzing safer, lower-impact alternatives to the project, including local pipeline alternatives.

16. A U.S. Chemical Safety Board (CSB) report on the 6 August 2012 crude unit fire at the Chevron Richmond refinery that documents the CSB's analysis recommending the need for both detailed hazard-specific safety analysis and switching to inherently safer industrial systems is appended hereto as Attachment K2-4. Much of the analysis in this CSB report is generally applicable to high hazard industries, and to this project.

17. The evidence outlined in paragraphs 9–16 indicates that the detailed estimates of project-related oil train transit and unloading emission, and incident, hazards in the FEIR (which itself finds these impacts would be significant) are more likely to underestimate than to overestimate the impacts of these emissions and hazards. This evidence further supports the Staff Report findings regarding the severity of these project impacts.

18. Based on my experience, knowledge and expertise and the evidence presented and discussed in paragraphs 4–17, in my opinion the project would be likely to result in the significant pollution and catastrophic hazard impacts associated with crude oil delivery via rail that are identified in the Staff Report

Impacts of No Project Alternative are Overestimated: The FEIR overestimates the impacts of the No Project Alternative by overestimating its effect on oil truck traffic.

19. The FEIR estimates increased emission and hazard impacts even if the project does not proceed (§ 5.0) based on its assumption that the "No Project Alternative" will result in dramatically increased oil trucking of imported oil for the SMF. (pp. 5-3, 5-4.) Specifically, it assumes: out-of-state crude imports to the SMF would rise by 19,200 b/d; 100 more oil trucks/day would drive a 220-mile round trip from Bakersfield to deliver that imported oil to the Santa Maria Pump Station (SPMPS), and oil train trips to load those trucks in the Bakersfield area would increase by 2.5 unit trains/week. (Id.)

20. The FEIR's assumption requires a future decline in local crude supply to the SMF. This is disclosed in vague terms by the FEIR,[5] and the data show that the FEIR's reliance on declining local crude supply for its "oil trucking" option is mathematically certain. Baseline local crude supply to the SMF averages at least 35,550 b/d.[6] Thus, no more than 13,400 b/d can be added, on average, under the SMF's 48,950 b/d throughput limit.[7] Therefore, the oil trucking option cannot add 19,200 b/d of imported crude unless the local crude supply to the SMF declines below its current 35,550 b/d baseline level in the future.

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[5] Here, (p. 5-3), the FEIR posits that without the project SMF crude throughput could decline as local production decline continues. Elsewhere it insists that is "speculative" as it argues to limit the project scope analyzed (RTC at 5–9; CBE–78; CBE–82). Its project description is unstable.
[6] Based on 39,310 b/d average 2011–2013 SMF throughput (a low assumption; it was 41,635 b/d in 2013; FEIR at 2-37), 6,800 b/d SMPS input (FEIR at 5-3), 3,040 b/d of SMPS input locally sourced (Throughput Increase FEIR Table 2-4); and: 39,310 – (6,800–3,040) = 35,550 b/d.
[7] 48,950 b/d is the newly-relaxed limit permitted with the SMF Throughput Increase Project.

21. I respectfully re-assert my previous comment providing evidence that declining local oil supply is foreseeable.[8] The FEIR has replied that declining local supply is not relevant to its impact analysis, and that Phillips can respond by trucking more oil in to the SMPS (RTC 7–9), ignoring that its alternatives analysis finds impacts of this same supply change and response (<u>see</u> ¶¶ 19–20). Its further reply that this evidence does not account for new production projects (RTC CBE-78) misinterpreted this evidence. The evidence integrates changes in production technology, effort, and other factors based on measured performance over time. For example, the California Energy Commission Staff that developed the forecast method that my comment built upon reported in 2010:

> "Over the last 10 years, California's crude oil production has declined at an average rate of 3.2 percent per year. Between 2006 and 2008, the decline rate is lower, averaging 2.2 percent per year. The decreasing decline rates over the last couple of years may be in response to an increased level of drilling prompted by rising crude oil prices over the same period. … Despite the increasing drilling in California over the last decade, crude oil production continues to decline, albeit at a slightly lower rate over the last couple of years.[9]

22. Local crude is still most of the SMF throughput and is still produced in amounts that exceed SMF throughput, but the SMF has been processing a larger share of local crude production as major OCS producers see production drop to one-fifth of what it was in 1995, and see their main export pipeline only half full.[10] Meanwhile, the oil is getting harder to find, tap, and process, and climate constraints on all of this should only grow. These trends are clear enough to support making a reasonable future supply forecast.

23. The further decline in local crude supply that is required before the FEIR's oil trucking option can be implemented would idle additional local pipeline capacity. This would strongly incent efforts to repurpose the existing, idled infrastructure that might otherwise be a stranded asset. For example, some of the Plains All American Pipeline system could reverse flow to supply the SMF from the Bakersfield area via the Phillips 66 Line 300 from the Sisquoc Pump Station. A Santa Barbara County Energy Division map that illustrates the Plains All American and Line 300 pipeline routes, the SMF, and

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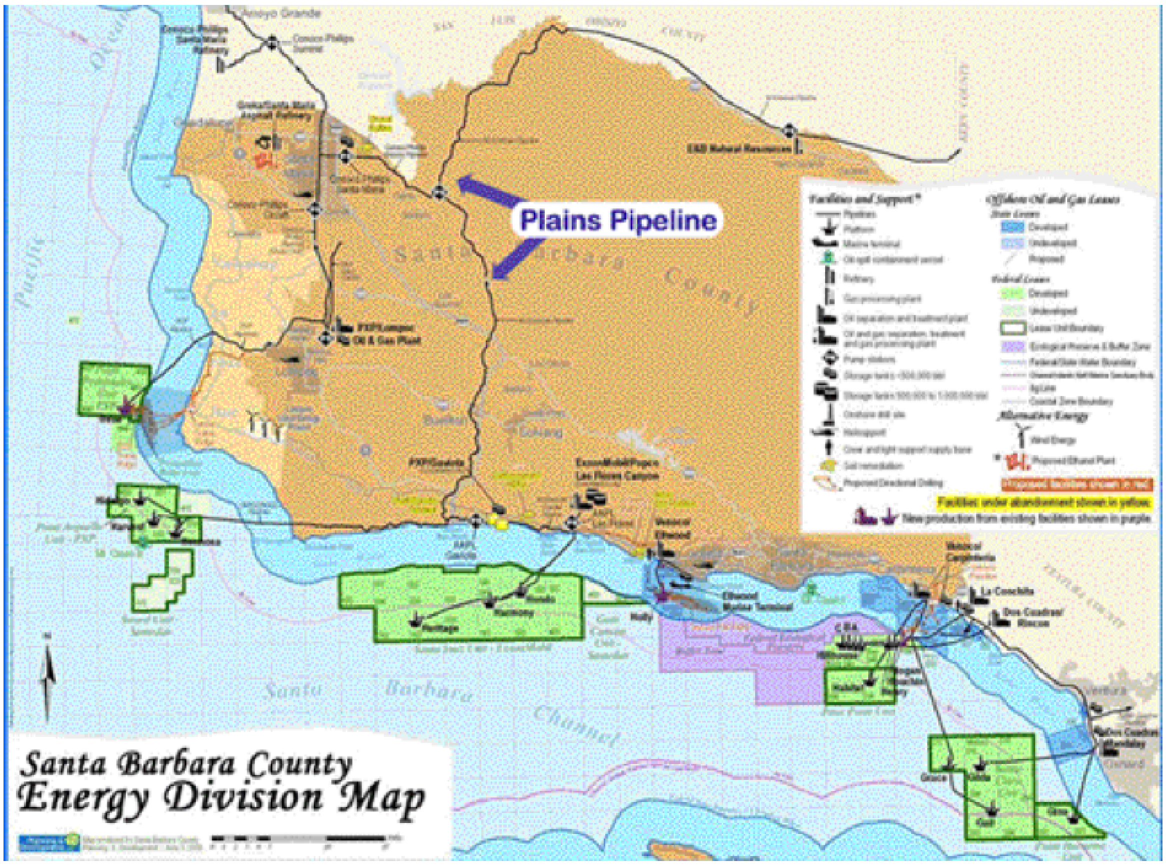
[8] Karras Report-1 at 4–9, Figure 1 and Exhibit 1.
[9] The quote is from California Energy Commission Staff Report CEC-600-2010-002-SF at 138.
[10] Based on production data for the Pt. Arguello, Pt. Perdenales, Pescado, Hondo, and Sacate platforms collectively, from Karras Report-1 Exhibit 1: All American Pipeline data from Santa Barbara County Planning (www.sbcountyplanning.org/energy/projects/PlainsPipeline.asp); <u>see</u> also FEIR at pp. 2-38 and 5-10; Karras Report-1 at 18 (quoting Foxgen EIR) and Exhibit 1.

other energy infrastructure in northern Santa Barbara and southern San Luis Obispo counties is excerpted below.



Santa Barbara County Energy Division Map, excerpted from: www.sbcountyplanning.org/energy/projects/PlainsPipeline.asp.

The Sisquoc Pump Station on the map is slightly below and to the left of the upper-most arrowhead indicating the Plains All American pipeline, below where the Plains line turns easterly toward Bakersfield. Line 300 runs toward the refinery from Sisquoc Station, to the Summit Pump Station. The 300,000 b/d capacity of the Plains line[11] and 84,000 b/d capacity of Line 300[12] would be ample for the SMF, and as pipelines tend to be costly to build and cheap to run, the opportunity to use an existing pipeline could be attractive.

[11] See: www.sbcountyplanning.org/energy/projects/PlainsPipeline.asp.
[12] See: www.sbcountyplanning.org/energy/projects/conoco.asp#onshore.

24. The FEIR acknowledges that the All American Pipeline can be reversed, objecting only that the continuing decline in local crude supplies that could trigger the reversal is "speculative." (RTC at 8, 9.) Further, in response to the Santa Barbara County Planning Director's comment seeking safer options that build on existing pipeline infrastructure, the FEIR describes the same All American Pipeline reversal option, this time objecting mainly that it could shift impacts to Kern County. (Att. K2-3 at SBC–06.) The FEIR's alternatives analysis ignores this local pipeline option, though its oil trucking option also relies upon declining local crude supply, and also would transfer impacts to Kern County. (¶¶ 19–22; and § 5.0, *esp.* pp. 5-3, 5-4.)

25. Excerpts from an attachment to comments on the RDEIR by Phillips 66 Co., including comments to the US Department of Transportation by the Railway Supply Institute, are appended hereto as Attachment K2-5. Among other things, this evidence indicates that transporting crude oil by pipeline is less costly than transporting it by train or by truck, and that this cost difference may be significant to refiners.

26. Relatively greater cost for crude oil transport by truck than by train, relatively lower cost for crude transport by pipeline, and the distinct transport cost advantage of pipelines, are further supported by the industry and trade literature. Westenhaus (2013) reported that "pipelines are lower cost" transport for crude oil as compared with all types of motor transport.[13] Snyder (2014) reported that fuel costs for oil transport are 37 times greater for trucking and roughly three times greater for rail as compared with river barge transport.[14] Hiller (2013) reported that in general, "it costs $20 per barrel to move crude oil by truck, $10 by rail and $5 by pipeline, although the cost varies by geography."[15] A 2008 U.S. Department of Transportation (USDOT) study[16] found greater line haul transport costs for all types of freight via truck than via rail. This USDOT study also found that increasing crude oil prices, which result in higher fuel costs, increase trucking costs more strongly than rail costs. Exhibits 13 and 15 from this USDOT study, presenting those comparisons, are excerpted herein below.

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[13] http://oilprice.com/Energy/Energy-General/Trucks-Trains-or-Pipelines-The-Best-Way-to-Transport-Petroleum.html.
[14] http://www.albertaoilmagazine.com/2014/06/athabasca-mississippi-oil-by-barge.
[15] http://fuelfix.com/blog/2013/07/28/crude-oil-will-continue-rolling-by-train/#14419101=0.
[16] USDOT, 2008. *Impact of High Oil Prices on Freight Transportation: Modal Shift Potential in Five Corridors;* Technical Report; http://www.marad.dot.gov/resources/maritime-publications.

Exhibit 13: Line Haul Trucking Costs as a function of Fuel Price

Scenario	$/Barrel	Diesel/Gal	Truck Cost/Mile	Fuel % of 2005 base	Truck % of 2005 base
2002 Historic	$28.85	$1.37	$1.41	53%	80%
2005 Base	$54.79	$2.40	$1.75	100%	100%
2020 Optimistic	$59.61	$2.61	$1.82	109%	104%
2020 Central	$91.03	$3.99	$2.28	166%	130%
2020 Pessimistic	$157.18	$6.88	$3.24	287%	185%

Exhibit 15: Rail Line-Haul Costs as a function of Fuel Price

Scenario	$/Barrel	Fuel % of 2005 base	Rail Cost per FEU-Mile	Rail % of 2005 base
2002 Historic	$28.85	53%	$0.30	84%
2005 Base	$54.79	100%	$0.36	100%
2020 Optimistic	$59.61	109%	$0.37	103%
2020 Central	$91.03	166%	$0.45	123%
2020 Pessimistic	$157.18	287%	$0.60	164%

From USDOT (2008). ***Impact of High Oil Prices on Freight Transportation.***

27. The evidence presented and discussed in paragraphs 20–26 indicates that the increase in oil train-to-truck transport assumed by the FEIR, and especially its 100 loads per day increase in oil trucking, would require a further decline in local crude supply, which in turn would enable and incent repurposing of existing pipeline infrastructure. In this future scenario, the cost per barrel–mile to deliver the crude by trucks would be greater than the cost to deliver it by repurposed existing oil pipelines, this evidence shows. Oil trucking costs could average several times pipeline costs per barrel, and the discrepancy may grow larger when oil (and fuel) prices rise.

28. The FEIR provides at least some cost information in its alternatives analysis for crude oil transport by other modes. For example, it discusses capital and operating costs of new multi-state pipelines versus long haul rail transport of crude. (§ 5.0.) Strangely, however, the FEIR does not provide any oil transport cost information for trucks. (Id.)

29. Comments by the Santa Barbara County Air Pollution Control District (SBCAPCD) that, among other things, note the correct Santa Maria Pump Station (SMPS) oil truck unloading throughput limit, are appended hereto, along with the FEIR's responses to these comments, as Attachment K2-6.

30. The FEIR commits clear and significant errors in its review of the No Project Alternative. The FEIR asserts that all of its assumed 19,200 b/d increase in trucked oil can be added to the 6,800 b/d baseline of existing oil truck deliveries to the SMPS without violating the current limit on truck deliveries to the SMPS. (FEIR at 5-3.) This current limit, it asserts, is 26,000 b/d. That is factually incorrect. It is 21,859 b/d. The SBCAPCD noted the error. (Att. K2-6 at SBCAPCD–05.) The FEIR responded by confirming that it had made the error and stating it had been corrected. (Id.) The error was corrected, stating the correct, 21,859 b/d, limit—on one page (p. 4.3-24), but the erroneous 26,000 b/d limit is still asserted and relied on by the FEIR's analysis of the No Project Alternative. (§ 5.0; *see* esp. p. 5-3.) Significantly, the Air District comment and partial FEIR correction show that adding 19,200 b/d (100 trucks/day) of crude oil deliveries to the 6,800 b/d baseline SMPS input would violate the 21,859 b/d SMPS throughput limit.[17] The FEIR misinforms the public about that fact, and obscures the error, in its uncorrected alternatives analysis. (*See* § 5.0; *esp.* p. 5-3.)

31. Unloading the increased flow of trucked oil to the SMPS that is assumed by the FEIR would require a permit action to resolve the potential violation of the SBCAPCD throughput limit described in paragraph 30. New or modified truck loading facilities also would likely be required in one or more locations near Bakersfield, under the FEIR's oil trucking scenario (*see* FEIR at 5-3), and also would likely require permitting actions.

32. Should any or all of these permits (¶¶ 30–31) come for decision, the potential impacts from 2.5 oil trains per week and 100 oil trucks per day, the impetus to find safer and cleaner options, and the likelihood that repurposing oil pipelines would be safer, less polluting and less costly than oil trucking would make permitting, financing and implementing the necessary infrastructure difficult at best.

33. The evidence in paragraphs 4–32 shows that changes in oil sources, truck and railway delivery, the ancillary actions to implement those changes, and the resultant oil truck and oil train-related impacts that the FEIR assumes in its No Project Alternative analysis describe alternative actions that partially achieve project objectives. This scaled-down version of the project alters and increases truck and railway deliveries of oil. It is predicated on changes from the oil supply baseline. It requires changes to equipment design, operation, or both, and permitting actions to implement some of these changes.

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[17] Based on: 6,800 + 19,200 = 26,000 b/d, which exceeds the 2,1859 b/d limit.

The impacts that could result from these changes in oil sources and transport would only occur because of these infrastructure modifications and permitting actions; they would not manifest simply because the project did not proceed, as the FEIR assumes. It errs by this assumption, and by replacing its No Project Alternative analysis with an analysis of this scaled-down version of the project. Because this prevents the public and officials from comparing environmental effects of the project with environmental effects should the project not proceed, these errors are fundamental.

34. Based on my experience, knowledge and expertise and the data and information presented and discussed in paragraphs 19–33, in my opinion the FEIR overestimates the potential impacts from not proceeding with the project. The FEIR wrongly includes impacts from new actions to import oil, in a train-to-truck scheme that is not reasonably likely to proceed given safer and lower cost options, in the "No Project" Alternative.

Significant Oil Refining Impacts of the Project

35. As stated, I have been asked: "Would the project be likely to result in significant air emission and catastrophic hazard impacts associated with oil processing that are not identified in the FEIR or the Staff Report, or are underestimated in the FEIR and the Staff Report?" In contrast to the analysis of oil delivery impacts addressed above, this question involves impacts of oil processing. The short answer is yes. The project would result in processing a greater volume of lower quality oil feedstock. This would increase emissions and process hazards at the SMF and the Rodeo Facility (RF) of the SFR, resulting in significant potential air quality, health, climate, and public safety impacts. These feedstock-driven effects are systemic, undisclosed by the FEIR[18] despite comments to address them, and obscured by incorrect and unsupported assertions in the FEIR that should, as an initial matter, be corrected.

36. Processing more oil creates more refinery products and byproducts, including air pollutants, pet coke and H_2S, LPG, diesel and gasoline, among others. The FEIR finds that the impetus to avoid declining SMF throughput is likely to spur alternatives to replace declining local crude supply with imported oil, should the project not proceed,[19]

[18] The FEIR identifies two impacts of the project crude switch related to processing—increases in toxic emissions from SMF tank fittings and in transport emissions from exporting sulfur freed in processing the post-project crude slate—but it does not identify other impacts discussed herein.
[19] *See* ¶¶ 19–34, *esp.* ¶¶ 20–22 documenting factual support for this finding.

and it forecasts 100% replacement of current SMF crude supplies with imported tar sands oil as a reasonable worst case for project impact analysis.[20] But the FEIR then dismisses comments that the project will affect process rates, implying that this same replacement of declining local supply with project-enabled imports is "speculative." (RTC at 7–9.)[21] The contradiction is crucial to analysis of both impacts driven by process rate and of the project's true scope, as the comments showed based on abundant evidence that the crude imports the project enables will be needed to achieve and maintain Phillips' throughput increase and LPG objectives. (Id.) This contradiction in the FEIR obscures potential impacts of the project.

37. Actual SMF crude throughput ranged from 37,600–41,630 b/d annually and averaged 39,310 b/d during 2011–2013. (FEIR at 2-36, 2-37.) Thus, running at the 48,950 b/d SMF throughput limit set via its Throughput Increase Project would increase SMF throughput. (Id.) The project design described in the FEIR has the capacity to supply all of this 48,950 b/d, 100% of permitted SMF throughput, and this is the project potential (¶¶ 5, 9),[22] consistent with the 100% crude replacement potential used by the FEIR (¶ 36) for impacts analysis. Therefore, the project would have the potential to increase refinery throughput.

38. Evidence that a clear, long-term trend of declining local crude supply, despite increased drilling effort, is likely to continue, driving the need for imported replacement oil enabled by the project, is addressed above. (¶¶ 21–22.) The FEIR misinterprets this evidence rather than rebutting it. (Id.) Moreover, the FEIR agrees that "[i]n the long-term, the need for the SMR rail project could be driven by declines in local production of crude oil." (p. 2-38.) Instead of saying it would not replace current oil sources, the FEIR notes that the project could operate for "20 or 30 years, if not longer" (Id.), concluding: "Therefore, it would be speculative at best to estimate when the local crude supply would not be sufficient to support further operation of the SMR without the proposed Rail Spur

[20] *See* RTC CBE-94 (confirming that it estimates fugitive BTEX emissions from SMR tanks and components based on a 100% imported tar sands crude slate); however, *see* also footnote 18.
[21] The FEIR repeats its implication that project effects on throughput are "speculative" (RTC 7-9; CBE-33, 75–79, and 82; ABJC-06); the argument is without merit (¶¶ 21–32, esp. 21–22, 29–30.)
[22] At its stated capacity to unload a train in ≈ 11.5 hours, the project would be limited to ≈ 344 trains/yr by the SMF limit of 48,950 b/d. (Karras Report–I at 3.) The newly-proposed 250 trains per year limit is not the project potential, and may not be adopted and kept—the SMF limit itself was relaxed recently (FEIR at 2-36), and the FEIR itself finds that many previously proposed mitigation measures are "speculative" in response to industry comments that they are preempted.

Project." (RTC at 9; *see* also CBE-33, CBE-78, CBE-82, and ABJC-06; emphasis added.) The project's potential to replace current SFR oil feeds is demonstrated by its capacity relative to that of the SMF (¶ 37), and is further supported by a clearly foreseeable need to replace dwindling current crude supply, regardless of any residual uncertainty about exactly when that need will arise during the 30-plus years the project could operate.

39. The FEIR asserts that hydrocracking and coking units at the RF "are currently operating at or near their permitted capacities as specified in the Title V Operating Permit." (RTC at 14.) The FEIR provides no actual throughput data to support this assertion. Available actual data, excerpted from the Fact Sheet attached to the current NPDES Permit for the RF, are appended hereto along with excerpts from its current Title V Permit, showing those permitted capacities, as Attachment K2-7. The NPDES Permit data show actual RF throughputs of 51,750 b/d for hydrocracking and 25,450 b/d for coking. (Att. K2-7.) Permitted capacities for these processes in the RF Title V Permit are 65,000 b/d for hydrocracking and 81,000 b/d for coking. (Id.) If these data are accurate the RF hydrocracking and coking throughputs could increase by 26% and 218%, respectively, before exceeding Title V permit capacities. With the increase in SMF throughput the project would enable (¶ 37), the RF would process additional semi-refined oil from the SMF, but this unsupported and apparently erroneous assertion in the FEIR obscures impacts of the project that could result from increasing RF throughputs.

40. My previous comment, that available data indicate increasing SMF throughput is limited by naphtha reforming capacity at the RF and additional RF LPG recovery could debottleneck the throughput increase, is not addressed by the vague reference to comment on "overload" of "existing Rodeo LPG recovery" in the FEIR. (RTC at CBE 84 and 85.)

41. The larger volume of semi-refined oil sent to the RF because of the increase in SMF throughput the project would enable (¶ 37) would supply more distillation, coking, and hydrocracking production of LPG along with other SFR products. As to the transport of LPG to the RF as LPG, the FEIR's claim that vapor pressure limits prevent additional LPG transport in the SMF–RF pipeline (RTC, CBE 100–108) is unsupported and wrong. Its assertion that available data showing current vapor pressures far below these limits are based only on estimates, even if true, is not supported by any other data on baseline vapor pressures along the pipeline route (Id.), and in any case, the increased volume of oil in the pipeline would enable more LPG transfer at any given vapor pressure limit.

42. The FEIR incorrectly assumes that the diluent intentionally added to bitumen for transport to the SMF would not be specified to contain a targeted product level of LPG. (p. 2-31; RTC at 12, CBE 84–85, CBE-111.) This assumption is not supported. The buyer could specify the composition of the intentionally added diluent. In other words, Phillips 66 could choose either the standard specifications for a dilbit that are presumably the averages cited in the FEIR (Id.), or it could specify diluent that meets its product target specifications, including diluent with higher LPG content. Moreover, the design specifications for Phillips' facilities and projects would certainly include crude slate quality specifications, but the FEIR fails to report or discuss them. Its assertion that the project would not produce more LPG at the SMF for transfer to the RF is unsupported.

43. Evidence regarding LPG recovery equipment project design and verification pilot testing that I provided to Contra Costa County in February 2015 is appended hereto as Attachment K2-8. This evidence shows that, contrary to the assertion in the FEIR that the pilot testing confirms sufficient recoverable LPG in the project baseline (RTC at 11), the pilot testing was timed to non-baseline crude imports matching the crude oils targeted by Phillips 66 for the post-project crude slate.

44. Processing lower quality oil creates more byproducts per barrel processed, including more air pollutants, substances that create more air pollutants when used as fuels, and substances that increase process hazards because they are flammable, explosive and corrosive. Oil quality characteristics that are known to affect refinery processing, and could change as a result of the project, but are not disclosed by the FEIR for the baseline or post-project crude slates, include but are not limited to: hydrogen content; asphaltene content; nitrogen content; process catalyst fouling; concentrations of trace elements including those of arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), lead (Pb), selenium (Se), uranium (U), and zinc (Zn); and distillation characteristics of the crude slates, including the characteristics listed above for each distillation cut and its density and volume.

45. The FEIR reports some of my previous work selectively and out of context while it appears to ignore, or to discard as pre-draft comment, some of my previous comments. Accordingly, the following evidence is submitted or re-submitted as appended hereto:

- Meyer et al. (2007), a USGS report, is appended hereto as Attachment K2-9;
- Karras (2010), as published in *Environmental Science & Technology,* is appended hereto, including its Supplemental Information appendix, as Attachment K2-10;

- Karras (2011), a UCS report, is appended hereto as Attachment K2-11;
- Bredeson et al. (2010), as published in the *International Journal of Life Cycle Assessment,* is appended hereto as Attachment K2-12;
- Abella and Bergerson (2012), as published in *Environmental Science & Technology,* is appended hereto as Attachment K2-13;
- Gordon et al. (2015) *Know Your Oil,* is appended hereto as Attachment K2-14;
- Karras (2015), a report for the NRDC, is appended hereto as Attachment K2-15;
- Karras (2013), a CBE expert report, is appended hereto as Attachment K2-16;
- Robinson and Dolbear (2007) is appended hereto as Attachment K2-17;
- Sánchez de la Campa et al. (2011), as published in the *Journal of Hazardous Materials,* is appended hereto as Attachment K2-18;
- Wilhelm et al. (2007), as published in *Environmental Science & Technology,* is appended hereto as Attachment K2-19;
- Excerpts from a Chevron Project EIR are appended hereto as Attachment K2-20;
- Karras et al. (1994), *Dirty Crude,* is appended hereto as Attachment K2-21;
- Baseline asphaltene data for crude oils is appended hereto as Attachment K2-22;
- Excerpts from a Phillips 66 (2012) overview and BAAQMD (2015) staff report regarding sulfur in fuel gas are appended hereto as Attachment K2-23;
- Excerpts from APCD emissions data are appended hereto a Attachment K2-24;
- An APCD Engineering Evaluation is appended hereto as Attachment K2-25; and
- CSB (2001), a refinery incident report, is appended hereto as Attachment K2-26.

46. “Tar sands” oil from the Western Canadian Sedimentary Basin is naturally occurring bitumen extracted from rock or sand formations. It is blended with lighter diluent oils for transport as dilbit. The project potential is to enable up to 100% tar sands dilbit refining at the SMF. (¶¶ 5, 9; FEIR RTC at CBE-94.) The current SMF crude slate is described as “heavy oil.” (FEIR at 2-34; 4.3-48; 4.7-93.) The FEIR asserts this full-blown switch to tar sands oil will not result in any significant change in oil feedstock processing. (RTC at 19–22.)[23] The FEIR is not accurate. Bitumen is described by U.S. Geological Survey scientists as “fundamentally different” from heavy oil with respect to properties that, among other things, affect oil products processing. (Att. K2-9 at 2, 3.) This authoritative view directly contradicts the FEIR’s project description on this point.

[23] The FEIR finds only “nominal” impacts, limited to fugitive tank emissions, export of sulfur recovered from crude, and corrosion, from this switch. _See_ also RTC at 11–14, CBE 119-120.

47. Hydrogen is the most abundant atom in crude, and with one-twelfth the mass of carbon, the variability in its abundance with changes in oil density is quite substantial. Hydrogen must be added to denser oils to make hydrogen-rich engine fuels, and refiners' on-purpose production of it, via the hydrogen steam reforming shift reaction, is a major carbon dioxide (CO_2) emitter. (Atts. K2 10–17.) Bitumen has ≈1 lb/b less hydrogen than heavy oil on average.[24] Making up this hydrogen deficiency would emit ≈10 pounds of CO_2 per barrel of bitumen refined instead of heavy oil, from hydrogen production alone.[25] Further, this figure underestimates hydrogen plant emissions, as still more hydrogen is used to remove contaminants from oil streams. (Atts. K2 10, 17.) The FEIR does not disclose the hydrogen content of the baseline or post-project crude slate.

48. Asphaltenes are large, high molecular weight, multi-carbon, hydrogen-deficient hydrocarbons featuring multiple carbon-carbon bonds and contaminants locked into this "lattice" of chemical bonds. Asphaltenes are refractory (hard to process), requiring severe processing to "crack" (break) them into fuel-sized hydrocarbons, remove their contaminants, and force hydrogen into these cracked hydrocarbon molecules. The asphaltene content of an oil stream is thus directly related to the severity of processing needed to make engine fuels from that oil. The asphaltene content of bitumen (26.1 wt%) is more than twice that of heavy oil (12.7 wt%) on average. (Att. K2-9 Table 1.) The FEIR does not disclose the asphaltene content of the baseline or post-project crude slate.

49. Contaminants that are more abundant in denser, higher-asphaltene oils include refinery process catalyst poisons such as sulfur, nitrogen, nickel and vanadium. (*See* ¶ 48; Atts. K2-10, K2-17.) The FEIR does not disclose the nitrogen content of the baseline or post-project crude slate. Degradation of catalyst activity caused by processing oils with more of these elements increases refinery emissions and hazards by causing among other things process instability, process upsets, and more frequent process shutdowns for catalyst change-outs. (*See* Atts. K2 15–17.) Processes vulnerable to these impacts are located in the RF. Sulfur is the most abundant of these catalyst poisons in crude by mass. (Att. K2-10.) The FEIR reports that the project could increase the sulfur content of the SMF crude slate (p. 4.3-49), but it does not address this process catalyst fouling impact.

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[24] From bitumen density (1,030 kg/m^3) and H_2 content (10.3 wt. %), heavy oil *d* (957 kg/m^3) and H_2 (11.4 wt. %) in Att. K2-9, Table 1 and: (1,030 • 0.103) – (957 • 0.114) = 3 kg/m^3 (1 lb/barrel).
[25] Based on energy and emissions of 16.4 MJ/m^3 H_2 and 52.7 kg CO_2/GJ from Att K2-10, 5.42 m^3/lb from the USDOE H_2 conversion calculator, and Δ ≈1 lb H_2/b crude from the note above.

50. Catalyst poisons are removed from oil streams, to protect downstream process catalysts and to meet product specifications, by bonding with hydrogen in hydrotreating and hydrocracking processes. (Atts. K2-10, K2-17.) For example, these processes remove sulfur as hydrogen sulfide (H_2S). As stated (¶ 47), this further increases the hydrogen requirements for processing lower quality oils. H_2S is a corrosive process hazard (Att. K2-4) as well as an acute exposure hazard in refineries. These specific hazards from catalyst poison removal, which would manifest at the RF after it receives the partially refined post-project oils from the SMF, are not addressed in the FEIR.

51. Arsenic (As), and other trace elements that the FEIR does not address, including but not limited to Cd, Cr, Cu, Fe, Hg, Pb, Se, U, and Zn, are contaminants of crude oil that pass through processing to be released by refineries. (Atts. K2-9, K2-18, K2-19.) Some these contaminants (Cu, Fe, Pb) are known to be more concentrated on average in bitumen than in heavy oil. (Att. K2-9.) Contrary to the FEIR's incorrect dismissal of emissions hazard from the pass-through of these crude feed contaminants (pp. 4.3-65, 4.3-66), metalliferous emissions from refinery process and combustion stacks have been measured in environmentally significant amounts. (Att. K2-18.) Because of this toxic pass-through potential the City of Richmond has required Chevron's Richmond refinery to monitor and report some of these elements (e.g., Cd, Hg, Se) in its crude slate, gas oil streams fed to its catalytic cracking and hydrocracking units, and its refinery fuel gas. (Att. K2-20.) The FEIR does not disclose or analyze As, Cd, Cr, Cu, Fe, Hg, Pb, Se, U or Zn in the baseline or post-project SMF crude slate.

52. The conclusion in the FEIR that refinery operation will not change based on the "similar" API Gravity (density) and sulfur content of pre and post project crude slates is incorrect. Crude density and sulfur content alone do not predict many oil quality-related impacts reliably at individual refineries, and do not predict some of these impacts at all. (Atts. K2 10–21.) Changes in specific characteristics of oil streams described above interact with specific processing of each oil stream, each with specific product targets, to cause emissions and process hazards that are not caused by—or necessarily predicted by—an individual refinery's crude slate density and sulfur content alone. (Id.) In one example that is relevant to the project crude switch, refinery release rates for some toxic trace elements are driven by the element's concentration in the crude feed, not its density or sulfur content. (Atts. K2-19, K2-21.) Another example: refinery hydroprocessing requirements in one region were higher than predicted by the density and sulfur content

of its non-diverse, poorly mixed crude slate that included tar sands oils. (Att. K2-10.) Another: The intentional dilution of bitumen with light oils for transport drives down the density and sulfur content of tar sands dilbit crude slates without changing the extreme contamination and processing characteristics of the bitumen in those crude slates. The FEIR cites my work (Atts. K2 10–11) without noting that, like other experts' work in this subject area (Atts. K2 13–14), it warns against estimating oil quality-driven impacts at an individual plant based on the density and sulfur content of its crude slate alone, and calls for disclosing and analyzing additional oil quality characteristics that the FEIR ignores.

53. As stated, the processing emissions and hazards from the project's crude switch would be caused by the specific characteristics of the oil streams fed to various specific refining processes with various product targets. (¶¶ 47–52.) Distilling a different crude slate at the SMF sends different volumes of naphtha, distillate oil and gas oil—each with different hydrocarbon composition, hydrogen content, and contaminant levels—to the RF as pressure distillate and gas oil. It also sends a different volume of resid with different asphaltene, hydrogen, sulfur and other contaminant contents to SMF cokers. The FEIR does not report these distillation characteristics quantitatively, with the sole exception (in a table on page 4.3-48) of baseline resid volume. Its chart graphing the *mass %* of naphtha, distillate, gas oil, and resid cuts in crude (Figure 2-11) is not supported by any other quantitative data in the FEIR and does not even reveal the volumes and densities of these distillation cuts. Another EIR disclosed and analyzed volume, density, sulfur and metals data for distillation cuts. (Att. K2-20.) The FEIR could have done so. As it stands, however, the FEIR does not disclose the crude distillation properties that actually impact refinery processing for either the baseline or the post-project crude slate.

54. The FEIR's conclusion that refinery processing will not change based on allegedly "similar" distillation properties of the pre and post project crude slates is unsupported and incorrect. There is no disclosure or analysis of potential changes in distillation properties that actually affect refinery processing in the FEIR (¶ 53),[26] and available information the FEIR should have included shows that the new crude slate would affect refinery processing. Volume data for naphtha distilling from Canadian dilbit crude oils (Att. K2-15)[27] confirm the FEIR's graphic suggestion (based on mass %; Fig. 2-11) that the new dilbit crude slate would yield more naphtha at the SMF, which

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[26] Except for its dilbit LPG distillation yields; assumed averages that may be too low. <u>*See*</u> ¶ 42.
[27] These dilbits' naphtha distillation cut averages 25 (range 20–28) vol%; Table S1 in Att. K2-15.

would be sent to the RF for gasoline and LPG production. This would support the LPG recovery objective, worsen a naphtha reforming bottleneck (*see* ¶ 40), or both, at the RF. Meanwhile, the combined yields of distillate oil and gas oil—key feedstocks for diesel and jet fuel production—from distilling the new crude slate would drop.[28] This would drive the SFR to hydrocrack more distillate from gas oil, make that extra gas oil feed by coking more resid, and support that increased coker feed with its throughput increase.

55. Crucially, the comparison of resid mass % yields in the FEIR (Fig. 2-11) obscures changes in the volume and density of resid yield resulting from the project. The average volume yield of resid would drop from 43 vol% of the baseline crude slate (FEIR, 4.3-48) to ≈ 37 vol% of the new dilbit slate (Att. K2-15)[29] and the new resid would be extremely dense. (Id.) This effect is caused by dilution with light oils that drives down volume % resid in dilbit, and the abundance of high-molecular weight, contaminated asphaltenes in bitumen (¶ 48) that are carried into the dilbit resid, making it extremely dense and highly contaminated. The even greater average density and sulfur content of Alberta dilbit resid (Att. K2-15)[30] than those of bitumen (Att. K2-9)[31] further confirms this effect. The lower volume of resid from each barrel, combined with the need to get more gas oil from the cokers to offset the drop in diesel and jet fuel feedstock distillation yields from the dilbit (¶ 54), would require distilling more crude for coker feeds, driving the project throughput increase. At the same time, the lower quality of the resid would further affect processing. But comparing only mass % yields (Fig. 2-11), the FEIR masks the changes by showing a lower volume of denser resid as a similar mass. Failing to disclose these changes in oil feedstock quality, the FEIR obscures these impacts.

56. Impacts of the project's crude switch are further obscured by the inaccurate characterization in the FEIR of comment on processing impacts. My previous comment, that lower resid quality would affect coker yields, supporting the LPG recovery objective

[28] Dilbits' distillate-plus-gas oil cuts collectively average ≈38 vol% (Table S1 in Att. K2-15) due to very low distillate yield (diesel and jet fuel feedstock) and low gas oil (hydrocracking feed for making distillate) yield. (Id.) Lower distillate-plus-gas oil yield is obvious in FEIR Figure 2-11.
[29] Further, Alberta dilbit resid yields range narrowly (≈ 36–39 vol%; 1,040–1,060 kg/m^3 density; 5.6–6.5 wt% sulfur). *See* Att. K2-15 Table S1. FEIR Table 4.3.13 gives unsupported vol% resid values for dilbits that appear to be wt% values: *see* Access Western Blend ASTM D2892, D5236 data from www.crudemonitor.ca for resid yield in April 2015 (37.3 vol%; 43.5 wt%), June 2012 (36.5 vol%; 42.4 wt%), and December 2009 (37.7 vol%; 43.8 wt%).
[30] Average from Table S1 ≈ 1,050 kg/m^3 density; 6.2 wt% sulfur.
[31] Average from Table 1 ≈ 1,030 kg/m^3 density; 4.4 wt% sulfur.

and worsening emission and hazard impacts,[32] remains to be addressed. Instead of responding to this comment, the FEIR asserts (incorrectly) that commentors "overlook" oil feedstock cracking effects on in-plant LPG supply. (RTC at 11, CBE-84 and 85.) The originally referenced data for oil feedstock effects on coker yield are tabulated below: as coker feed becomes denser and higher in sulfur (reflecting greater asphaltene content), coker yields increase for gases and coke but decrease for gas oil.

Table K2-1. Oil feedstock quality effects on delayed coking products yield.[a]

Coker feed example:		**A**	**B**	**C**	**D**
density	kg/m^3	952	981	1,010	1,040
sulfur	wt. %	0.5	0.6	3.4	5.3
Products yield					
C4– gases	wt. %	7.4	6.2	9.2	10.5
Naphtha	wt. %	20.4	18.5	17.4	21.4
Gas oil	wt. %	54.5	65.3	48.5	33.0
density	kg/m^3	850	919	902	931
sulfur	wt. %	0.4	0.6	2.3	4.3
Coke	wt. %	17.7	10.0	24.9	35.1
sulfur	wt. %	0.8	1.1	5.1	6.4

[a] Data from Meyers (1986) *Handbook of Petroleum Refining Processes;* tables 7.1-2 and 7.1-6. *See* also attachments K2-15 and K2-16. **C4–:** hydrocarbons with 4 carbons or less; LPG and other gases.

Note the combined effects of these changes in yield when the need to maintain gas oil yield for hydrocracker diesel production (¶¶ 54–55) is considered. Coking feed D in Table K2-1 yields 17 % more gases than coking feed C for an equal volume of feed,[33] but feed D yields 72 % more gases than feed C for an equal volume of gas oil yield.[34] Similarly, coking feed D yields 45 % more coke than feed C for an equal volume of feed, but yields 114 % more coke than feed C for an equal volume of gas oil yield.[35]

[32] *See* Att. K2-16 hereto, the "Expert Report of Greg Karras" dated 4 September 2013 *in* CBE's 24 November 2014 comments (Attachment A as posted on the County's Web Site).
[33] Based on 10.5 wt% of 1,040 kg ($1m^3$ feed) = 109 kg (feed D); 9.2% of 1,010 = 92.9 (feed C).
[34] From above (D 109; C 92.9 kg/m^3 feed); gas oil m^3/m^3 feed (D: 0.33 • 1,040/931 = 0.369), (C: 0.485 • 1,010/902 = 0.543); 109/0.369 = 295 kg gases/m^3 gas oil yield from feed D versus 92.9/0.543 = 171 kg gases/m^3 gas oil from feed C; and 295/171 = 1.72 (172 %).
[35] Using coke wt. % yields (feed D: 35.1; feed C: 24.9) in the calculations noted directly above.

57. It is a critical and standard petroleum engineering practice, for new equipment to be designed for new feedstock and product targets, to develop detailed specifications based on pilot testing before making a major capital commitment to a project. Phillips 66 certainly would have done so in this case—and did. The FEIR admits that the LPG recovery equipment "design basis was derived from data taken at the Refinery in August 2011" (RTC at 11), but it does not disclose the design basis oil quality specifications, only disclosing a summary of LPG allegedly recoverable based on these pilot tests. (Id.) Further, the FEIR does not report the crude slate these tests piloted, and thereby omits evidence that, coinciding with this pilot testing—and the confirmation testing during 2013—different, non-baseline crude oils were imported to the SFR for processing. (Att. K2-8; *see* also ¶43.) The FEIR conflates this project design data with baseline data. Its assertion that this project design data proves the project is not needed for Phillips' LPG recovery objective (RTC at 10–11, CBE 84–85, CBE-111) is unsupported and incorrect. What it proves is that project potential data exist which remain undisclosed—including these project design basis crude slate quality characteristics.

58. Consistent with the extreme asphaltene content of bitumen (26.1 wt. %; ¶ 48), the average density (1,050 kg/m^3) and sulfur content (6.2 wt. %) of the resid in post-project dilbit crude slates (Att. K2-15) are extremely high, exceeding any of those in the coker feedstocks shown in Table K2-1. In comparison, and consistent with the much lower asphaltene content of heavy oil (12.7 wt. %) than bitumen (¶ 48), available data indicate that the average asphaltene content of California-produced crude streams (12.2 wt. %), and local crude oils supplying the SMF (15.3 wt. %), is much lower than that of bitumen. (Att. K2-22.) Further, the higher asphaltene content of bitumen is reflected in its higher density and sulfur and lower hydrogen content than heavy oil. (¶¶ 47–49.) This evidence indicates that the "heavy oil" (¶ 46) baseline crude slate can be expected to have higher hydrogen content and to yield resid that is lower in asphaltenes, density and sulfur,[36] as compared with the post-project tar sands dilbit crude slate.

59. Complete and precise estimates of project oil feedstock processing impacts are limited by the failure of the FEIR to disclose and compare project design crude slate specifications with baseline crude slate data for the oil quality and volume characteristics discussed above. (¶¶ 36–57.) Impacts from undisclosed changes in oil feedstock processing that are reasonably foreseeable based on data and information disclosed by

[36] The FEIR (p. 4.3-49) appears to acknowledge this potential with respect to avg. sulfur content.

commentors can, in many cases, be evaluated as "project potential" estimates. Some of these impacts are identified and evaluated in this way herein below. Additional impacts from changes in oil feedstock processing that remain undisclosed by the FEIR may still occur, however. All of these impacts should be addressed in a corrected and complete EIR, should the County's review of the project proceed.

60. The data in Table K2-1 indicate that lower quality feedstock can increase coker off-gas yield by as much as 72 %. (¶ 56.) Though a precise estimate for the project-driven increase is limited by the FEIR's failure to disclose oil quality data, the project is reasonably likely to increase coker off gas significantly. The density and sulfur content of coker feed from the new dilbit crude slate would be off scale-high compared to the feeds shown in Table K2-1 (¶ 58), and it could have ≈ 71 % greater asphaltene content than that of the baseline crude feed. (Id.)[37] The extreme sulfur content of the project coker feed these gases are cracked from (Id.) could also increase their sulfur content. In addition to H_2S, sulfur compounds in coker off gas include mercaptans and non-acidic compounds that are resistant to fuel gas scrubbing with amine solutions. (Att. K2-23.) The SMF fuel gas treatment system relies on amine scrubbing. (Throughput Increase FEIR § 2.0.) Sulfur compounds in gases from coking would thus pass through fuel gas treatment in larger amounts as a result of the project. The additional coker gas would enter the SMF fuel gas, displacing cleaner-burning natural gas, and increasing emissions per barrel crude throughput from combustion sources across the SMF.

61. Similarly, the cokers at the SMF would likely produce more petroleum coke (¶¶ 56, 58), and the data in Table K2-1 suggest that the lower quality post-project crude slate could increase coke yield from refinery coking by as much as 114 %. (Id.) Contrary to the incorrect assertion in the FEIR that the project would not cause coke production impacts (p. 4.3-49; RTC CBE-94, CBE-120), emissions from transport and offsite burning of the additional coke would be impacts of the project.

62. Moreover, substantial "fugitive" emissions of reactive organic gases (ROG) that include toxics such as benzene occur during the decoking phase of the cokers' process cycle (Att. K2-15), and these emissions increase with increasing coker throughput. (Id.) The need to coke as much as 47 % more feed to maintain gas oil yield (¶ 56)[38] would

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[37] From bitumen (26.1 wt. %) v. heavy oil (15.3 wt. %) asphaltenes and 26.1/15.3 = 1.71 (171%).
[38] From feed C (0.543) and feed D (0.369) m^3 gas oil/m^3 feed, and 0.543/0.369 = 1.47 (147%).

likely result in greater coker throughput, increasing fugitive emissions from decoking as a result of the project. The FEIR does not identify, evaluate or mitigate these oil quality-driven impacts from changes in coker processing (¶¶ 60–62) resulting from the project.

63. Processing lower quality crude could increase CO_2 emissions as a result of the project. In one important example, the project could switch the SMF crude slate from heavy oil to bitumen with ≈ 1 lb/barrel less hydrogen on average. (¶¶ 46–48, 52, 55, 58.) As the SMF does not have hydrogen addition processing, this hydrogen deficiency in the SMF crude feed would be carried in the semi-refined oils transferred to the RF. Making up this deficiency would be necessary to meet engine fuel product targets, and require producing and adding hydrogen to the oil streams. The RF would rely on existing steam reforming for the extra hydrogen. This process emits ≈ 10 pounds of CO_2 per pound of H_2 produced. (¶ 47.) Thus, at ≈ 1 lb/b less hydrogen in the 70% of the new SMF crude slate that would not be added diluent (34,300 b/d),[39] CO_2 emitted from steam reforming to make up this hydrogen deficiency alone could exceed 55,000 metric tons per year.[40] This effect would increase emissions per barrel of crude refined and is additional to the emissions increase that would result from the project effect on crude throughput volume.

64. Refinery emissions can generally be expected to increase, unless otherwise mitigated, in proportion to increasing process throughput rates. The project has the potential to increase SMF throughput by 24.5 %, from a 2011–2013 average of 39,310 b/d to a post-project potential of 48,950 b/d. (¶¶ 36–39, 54–56.) Based on data reported by the California Air Resources Board,[41] during this 2011–2013 period the SMF emitted an average of 244,000 metric tons/year as CO_2e. Applying the potential 24.5% increase in throughput would estimate a project potential to increase SMF emissions of CO_2e by more than 59,000 metric tons per year[42] from this throughput increase alone.

65. Toxic and smog-forming pollutant emissions could increase in proportion to increasing process throughput rates as a result of the project. (See ¶ 64.) Based on SLOC Air Pollution Control District data (Att. K2-24), during 2011–2013 the SMF emitted reactive organic gases (ROG) at an average rate of 36.4 short tons/year. In this period the

[39] Assuming 30% of the 48,950 b/d SMF crude throughput capacity is diluent without the H_2 deficiency: this is a conservative assumption, as the diluent is often produced from bitumen.
[40] Based on 34,300 b/d • 9.7 lb CO_2/b • 365 days/year • 0.000454 metric tons/lb = 55,133 MTY.
[41] Facility emissions: http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm.
[42] Based on 24.5% of 244,000 metric tons/yr, and 24.5/100 • 244,000 = 59,780 MTY.

SMF also emitted an average of 71.3 tons of nitrogen oxides (NOx) per year and 156 tons of sulfur dioxide (SO_2) per year. (Id.) At the project potential throughput increase of 24.5 % (¶¶ 36–39, 54–56), the project could increase SMF ROG and NOx emissions by a combined increment of 26.4 short tons/yr, and could increase SMF SO_2 emissions by 38.3 tons/yr[43] due to this throughput increase alone. Oil quality-driven effects (¶¶ 60–63) would further increase post-project emissions above these throughput-based estimates. These process related emissions from the project that the FEIR fails to identify would exceed its 25 tons/yr significance threshold for ROG + NOx emissions.

66. Phillips 66 revised its throughput increase application in late 2014, seeking a temporarily lower average crude throughput limit (≈ 46,200 b/d), to be revised upward later, because it could not yet identify offsets for the emissions from boosting throughput to the County-approved average of 48,950 b/d. (Att. K2-25.) Undisclosed in the FEIR, this remarkable evidence reveals, among other things,[44] additional support for significant throughput-driven emissions. Moreover, even the 46,200 b/d temporary limit increases crude throughput by 17.5 %,[45] mitigation for the County-permitted project potential rate of 48,950 b/d is not yet identified (Id.), and the project's oil quality effects (¶¶ 44–63) will occur at any crude rate. For example, the hydrogen-poor crude feed effect increases CO_2 emissions by ≈ 52,000–55,000 metric tons per year (MTY) at crude throughputs of 46,200–48,950 b/d,[46] and the throughput effect increases them by ≈ 43,000–59,000 MTY at 46,200–48,950 b/d,[47] for a total CO_2 emission increment of ≈ 95,000–114,000 MTY. Any of these increments exceed the FEIR's significance threshold (10,000 MTY), and also its statewide project emissions estimate for CO_2e (16,723 MTY), by wide margins.

67. Failures to recognize and preventively address process hazards have repeatedly caused catastrophic incidents in refineries, resulting in multiple fatalities, and offsite pollution episodes impacting thousands of people. (*See* Atts. K2-4, K2-26.) Switching to a lower quality crude slate has repeatedly been found to be a contributing cause of these catastrophic incidents. (Id.)

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[43] This far exceeds the FEIR's 0.56 tons/year county-wide project SO_2 estimate (p. 4.3-51).
[44] The FEIR does not mitigate these impacts at least in part because it does not identify impacts resulting from the interrelationship between Phillips' proposals; *see* also ¶¶ 36–43, 52–58.
[45] From 39,310 b/d average throughput 2011–2013 (¶ 64), and 46,200/39,310 = 1.175 (117.5%)
[46] High end from ¶ 63; low end from 70% of 46,200 (32,340 b/d) instead of 48,950 b/d (34,300) in ¶ 63 calculation and: 32,340 b/d • 9.7 lb CO_2/b • 365 d/y • 0.000454 MT/lb = 51,983 MTY.
[47] High end from ¶ 64; low end from ¶ 64 calculation and 17.5% of 244,000 = 42,700 MTY.

68. An authoritative investigation of a recent catastrophic failure incident involving corrosion accelerated by crude slate switching at a California refinery recommended imposing requirements to formally analyze and implement "inherently safer systems" (ISS) in refineries statewide. (Att. K2-4.) This recommendation was based on specific findings that ISS is necessary <u>in addition to</u> inspection and maintenance, process hazard analysis, positive materials identification, mechanical integrity analysis, and management of change safeguards—thus in addition to the ongoing measures cited as "mitigation" in the FEIR—in refineries. (<u>Id</u>.) ISS analysis must be specific to the hazard analyzed (<u>Id</u>.) and, by definition, ISS includes, but is not limited to, consideration of process input substitution, e.g., avoiding an unnecessarily hazardous new crude slate.

69. The increased quantity of corrosive, acutely toxic H_2S in the SMF fuel gas recovery and treatment systems that would result from the project (¶¶ 36, 50, 56, 60) would increase the frequency and magnitude of H_2S releases in the SMF over time, and thus the potential for a catastrophic gas release incident. This catastrophic hazard could result in irreversible impacts, and is not mitigated adequately, because the FEIR did not identify, or include an ISS analysis of, this hazard in the FEIR. (<u>*See*</u> ¶¶ 67–68.)

70. Changes in processing caused by the project's effects on oil feedstock quality and throughput (¶¶ 36–41, 46–58, 60) would result in larger quantities of toxic, corrosive, and flammable or explosive gases being present in severe processing conditions at high temperatures and pressures in multiple process vessels at both the SMF and the RF. The oil feed quality and throughput changes resulting from the project would thus increase the frequency and magnitude of process upsets, malfunctions and failures that could, over time, result in catastrophic incidents at either or both facilities. Because the FEIR did not identify and did not include an ISS analysis of this specific hazard, and it could result in catastrophic and irreversible impacts, it is not mitigated adequately. (¶¶ 67–68.)

71. Increased sulfur and TAN (organic acid) content in the project potential crude slate, and the resultant potential for sulfidic corrosion, and naphthenic acid corrosion, hazards to increase because of the project are acknowledged and discussed at some length in the FEIR. (§ 4.7.) However, the FEIR does not identify or address the specific hazard of worsened corrosion in certain processing environments caused by both damage mechanisms acting together. (<u>Id</u>.) Further, despite the difficulty of predicting exactly where and when corrosion hazards will occur using non-destructive process monitoring methods, the FEIR does not include ISS analysis of any corrosion hazard. (<u>Id</u>.) Worse,

the FEIR inappropriately dismisses the significance of these corrosion hazards based on comparisons of sulfur and TAN levels in the range of individual oils processed rather than the average levels in the actual, blended, pre *vs.* post project crude slates. (Id.) In fact, the corrosion typically worsens over time (Att. K2-4), and can accelerate as the average level of a corrosive agent in the feedstock increases over time (Id.), whether or not the new feedstock is within the refinery's "operating envelope" range of feeds. (Id.)

72. The FEIR agrees the project could increase SMF crude slate sulfur content, but does not discuss the change in nitrogen content of the crude slate, or the potential impact from more frequent process unit shutdowns to address process catalyst fouling, which is caused by both of these process catalyst poisons. (¶ 49.) This impact would occur at the RF (Id.) and worsen a specific process hazard: increased incidence of flaring and potentially catastrophic upsets caused by increased frequency and cumulative duration of unstable process conditions during shutdowns and startups to address catalyst fouling by the lower quality crude slate. High-hazard processes, including the RF hydrotreating, hydrocracking, and reforming processes that could be affected by this increased catalyst fouling, are less stable when they are not operating in steady state conditions. As the Rodeo facility management reported to the Bay Area Air Quality Management District:

> "More importantly, the safest operating conditions for a unit are when it is out of service or when it is running at normal conditions. The transition period, which occurs during startup and shutdown, requires special attention and procedures. Equipment placed under these conditions experience temperature and pressure changes which can result in hydrocarbon leaks. Due to these factors it is necessary to minimize the duration of transition periods."
>
> *Flare Minimization Plan, BAAQMD 12-12: ConocoPhillips, San Francisco Refinery, BAAQMD Plant 16;* October 1, 2011, Rev. 7 at page 4-5.

The FEIR does not identify, evaluate, or mitigate this specific process hazard that would likely worsen as a result of the project.

73. With respect to the need for inherently safer systems (ISS) analysis of project hazards, the FEIR asserts crude supply choices will be driven by "market forces" alone. This assertion is unsupported—and it is contradicted by the FEIR's proposal to impose a 30º API limit on crude to be delivered by the project. (HM-2d.) Should the County choose to expand such limits to protect against the processing impacts of crude oils addressed herein, crude oil streams with much less extreme processing characteristics and hazards than tar sands bitumen are commercially available on the global crude oil market.

74. Based on my experience, knowledge and expertise and the data and information presented and discussed in paragraphs 35–73, in my opinion the project would be likely to result in significant air emission and catastrophic hazard impacts that the FEIR does not identify, caused by changes in crude slate volume and quality it does not disclose. The Staff Report does not identify these significant impacts either, apparently because its findings regarding refinery processing impacts of the project rely upon the FEIR.

75. I have given my opinions on these matters based on my knowledge, experience and expertise and the data, information and analysis discussed in this report.

I declare under penalty of perjury that the foregoing is true of my own knowledge, except as to those matters stated on information and belief, and as to those matters, I believe them to be true.

Executed this 23rd day of February 2016 at Richmond, California

Greg Karras

Attachments List

Attachment K2-1. World Health Organization, 2006. *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide; Global update 2005;* Summary of risk assessment; Report # WHO/SDE/PHE/OEH/06.02.

Attachment K2-2. Krogh et al., 2015. *Crude Injustice on the Rails: Race and the Disparate Risk from Oil Trains in California;* CBE and ForestEthics; June 2015.

Attachment K2-3. Russell, 2014. *Comments on the Proposed Phillips 66 Company Rail Spur Project Recirculated Draft Environmental Impact Report;* comments on behalf of the County of Santa Barbara, Planning and Development; also includes FEIR responses.

Attachment K2-4. U.S. Chemical Safety and Hazard Investigation Board, 2013. *Interim Investigation Report: Chevron Richmond Refinery Fire;* final report adopted Apr. 2013.

Attachment K2-5. *Phillips 66–Rail Project–Comments on RDEIR (SCH#2013071028);* excerpts from attachment to Phillips 66 comments emailed by G. McGowan on 24 November 2014; includes excerpts from an attachment by the Railway Supply Institute.

Attachment K2-6. Pearson, 2014. *SBCAPCD Review of Recirculated Draft Environmental Impact Report for Phillips 66 Company Rail Spur Extension Project;* Santa Barbara County Air Pollution Control District; includes SLOC responses.

Attachment K2-7. *Rodeo Facility Throughput Excerpts;* includes tables F-1C and F-1D of NPDES Permit No. CA0005053 Attachment F – Fact Sheet, and pages 11 and 13 of Table II A in the Title V Permit for the Phillips 66 Facility # A0016.

Attachment K2-8. *Expert Report of Greg Karras Regarding the Phillips 66 Company Propane Recovery Project Recirculated Final Environmental Impact Report;* 2 February 2015; includes report and 5 attachments giving LPG pilot test oil imports information.

Attachment K2-9. Meyer et al., 2007. *Heavy Oil and Natural Bitumen Resources in Geological Basins of the World;* U.S. Geological Survey Open-File Report 2007–1084.

Attachment K2-10. Karras, 2010. Combustion Emissions from Refining Lower Quality Oil: What Is the Global Warming Potential? *Environmental Science & Technology* **44**(24): 9584–9589. DOI: 10.1021/es1019965. Includes Supplemental Information (SI).

Attachment K2-11. Karras, 2011. *Oil Refinery CO_2 Performance Measurement;* prepared for the Union of Concerned Scientists (UCS): Berkeley, CA. September 2011.

Attachment K2-12. Bredeson et al., 2010. Factors Driving Refinery CO_2 Intensity, with Allocation into Products. *International Journal of Life Cycle Assessment* **15:** 817–826.

Attachment K2-13. Abella and Bergerson, 2012. Model to Investigate Energy and Greenhouse Gas Emissions Implications of Refining Petroleum. *Environmental Science & Technology*. DOI: 10.1021/es3018682.

Attachment K2-14. Gordon et al., 2015. *Know Your Oil: Creating a Global Oil-Climate Index;* Carnegie Endowment for International Peace: Washington, D.C.

Attachment K2-15. Karras, 2015. *Toxic and Fine Particulate Emissions from U.S. Refinery Coking and Cracking of 'Tar Sands' Oils;* includes Supplemental Information; Natural Resources Defense Council: San Francisco, CA.

Attachment K2-16. Karras, 2013. *Expert Report of Greg Karras Regarding the Phillips 66 Company Propane Recovery Project Draft Environmental Impact Report.*

Attachment K2-17. Robinson and Dolbear, 2007. Commercial Hydrotreating and Hydrocracking. In *Hydrocracking of Heavy Oils and Residua;* Ancheyta, J., Speight, J.G., Eds; Chemical Industries; CRC Press, Taylor & Francis Group: Boca Raton, FL.

Attachment K2-18. Sánchez de la Campa et al., 2011. Size Distribution and Chemical Composition of Metalliferous Stack Emissions in the San Roque Petroleum Refinery Complex, Southern Spain. *Journal of Hazardous Materials* **190:** 713–722.

Attachment K2-19. Wilhelm et al., 2007. Mercury in Crude Oil Processed in the United States (2004). *Environmental Science & Technology* **41**(13): 4509–4514.

Attachment K2-20. City of Richmond, 2014. *Chevron Refinery Modernization Project Environmental Impact Report: State Clearinghouse No. 2011062042;* excerpts including Appendix 4.3-URM (Unit Rate Model) and Six Element Test Reports. Richmond, CA.

Attachment K2-21. Karras et al., 1994. *Dirty Crude: The First Oil Industry-wide Analysis of Selenium Discharge Trends Impacting San Francisco Bay;* CBE Report No. 94-1; March 1994; Communities for a Better Environment: Richmond, CA.

Attachment K2-22. *Baseline Asphaltene Data: California-produced and Santa Maria Facility-sourced Crude Oils;* includes 23 crude oil assay reports and a summary table.

Attachment K2-23. Excerpts from Phillips 66, 2012. *Propane Recovery Project Overview;* and Bay Area Air Quality Management District, 2015. *Petroleum Refinery Emissions Reduction Strategy: Initial Report, Appendix C;* includes fuel gas information.

Attachment K2-24. San Luis Obispo County Air Pollution Control District, various dates. *SLOCAPCD Emission Inventory Data;* excerpts; includes Facility Emission Summary data for the Santa Maria Facility (refinery) for 2011, 2012, and 2013.

Attachment K2-25. San Luis Obispo County Air Pollution Control District, 2014. *Authority to Construct Engineering Evaluation, Appl No: 6015, Phillips 66 Co.*

Attachment K2-26. U.S. Chemical Safety and Hazard Investigation Board, 2013. *Investigation Report: Refinery Fire Incident (4 Dead, 1 Critically Injured), Tosco Avon Refinery, Martinez, California, February 23, 1999;* Report 99-014-I-CA. March 2001.